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ABSTRACT

This paper summarizes what physicists can bring to school science and what work in school science curriculum development has given, through the work of college and university physicists, to physics education. The physicist brings the similarity of the style of understanding as a child, which is inquisitive experimentation. He also has a perspective on the operations and processes of science gained through detailed involvement in the knowledge, content and development of the subject. Physicists in return have gain a perspective on the teaching of physics at the college level and have created closer ties between schools and colleges. A by-product has been the building of important interrelationships between the several components of the curriculum, especially math and science. (Author/TS)

James H. Werntz
2 February 1971

Contribution to a Panel Discussion on:

What Physicists Have Been Doing With Elementary School Science

As my contribution to this discussion, I would like to look at two facets of the interaction between the elementary schools and physics as effected by the men who have done work in both. First, I want to summarize what physicists can bring to school science, based on my observations of what they have--and have not--brought; and then I want to summarize what work in school science curriculum development has brought back, through the work of college and university physicists, to physics education.

In the end I shall be developing the thesis that the value of school curriculum develo[illegible] not in the resulting materials--important, even essential, as they may be--but in the effects on the individuals who have been so engaged. Or to say it another way, somewhat less sentimental, school curriculum development is in fact--and must be thought of as--a process and not a set of ordered states.

Paper presented at AAPT meeting, February 1971

I. What Physicists have contributed to Elementary School Science

The primary contribution of physicists to the elementary schools has resulted from their perspective on the operations and processes of their science. Their contribution is seldom, if ever, from the substance or knowledge of physics (except, of course, at the upper levels of the schools where it is thought appropriate to begin to develop the idea of discrete bodies of knowledge). I do not say that knowledge and substance have nothing to do with a physicists contribution to the school science: To the contrary, no one knows any way to gain a perspective on the processes and operations of physics except through detailed involvement in the knowledge, content and development of the subject. But it is the perspective so gained that is of importance to the schools and not the knowledge by which the perspective was gained.

For example, the ideas of translational, rotational and bilateral symmetry are coming to play an important

part in the elementary school curriculum. These ideas, properly developed through activities, turn out to be particularly attractive to even the youngest school children both for their aesthetic qualities and their analytic qualities. From the perspective of the physicist, ideas of symmetry are important not just because of the physical models to which they relate--substance which is far removed from anything appropriate to the elementary schools--but more importantly because of the relationships which ideas of symmetry suggest. As an illustration: elements of the symmetry between space and time are quite accessible to kindergarten children through translational symmetry in space--repetition of a pattern--and through translational symmetry in time--rhythm patterns.

Perhaps the most important contribution of the perspective of the physicist to the schools follows from the remarkable similarity between the style of understanding of the physicist and the style of understanding of the child. Some of the most important recent contributions

to developmental psychology are built on elements of this observation. The scientist and the child proceed on the belief that the world around him is understandable. The child proceeds to his understanding by imaginative activities called "play." The scientist has other words for an activity--investigation, experimentation--which have remarkable similarity to the play of children. The schools have gone very far away from programs which encourage and stimulate a playful attitude toward learning (probably for some of the same sorts of reasons that the typical college physics curriculum has gone very far away from the activities of doing physics). Physicists--with other natural scientists--have made small but significant contributions to returning school activity to the style of understanding of children through their systematic efforts to inject genuine scientific thought and activity into the schools.

A second major contribution of physicists to the schools has come from his usually-but not always-gentle

insistence that there are important interrelationships between the several components of the curriculum. We have, alas, come to the sorry state that the school curriculum from the very beginning is organized along the lines of our graduate schools. Such an organization may well be justified at the level of the development of knowledge where analysis is the primary tool; but it is patently absurd as applied to the intellectual development of the young where the process is, if anything, synthetic and not analytic.

The efforts of natural scientists in school curriculum development have made small dents in the walls which separate the art curriculum from the social studies curriculum from the language arts curriculum, etc. But it has actually knocked holes in the wall which separates the science curriculum from the mathematics curriculum, at least at the elementary level. For reasons obvious to this audience, ideas of graphical representation,

measurement (which traditionally has been in the domain of the mathematics curriculum for reasons which are lost in history), function, probability and statistics, analysis, inequalities and order of magnitude computation are appearing, with success, in the science curriculum while the mathematics curriculum wallows in the misery of numerical computation. This tension between the well-established arithmetic curriculum and the latter-day science curriculum has produced evidence that important changes in the mathematics curriculum are possible. The potential for significant improvement in one area of the curriculum from pressures from another area of the curriculum should not be forgotten by the scientists if and when science is accepted as an essential element of the elementary school curriculum.

I have one caution which I feel it important to make in describing the contribution of physicists to the improvement of science in the schools. The evidence is mounting

that significant contributions to this effort cannot be made through incidental consultation with those who carry the formal responsibility for school instruction. The intellectual problems of school science curriculum are too deep and the social chasms between the schools and the universities are too wide to permit significant interaction except through near total commitment. There are a few remarkable individuals who have continued to function creatively in both environments. But the substantial part of the contribution has been from physicists who have chosen to direct their creative energies to the improvement of school practice. I think it of primary importance that the individuals involved and the institutions which support them have a clear understanding of this phenomenon.

II. What School Curriculum Development has brought to Physics and Physics Education

Almost without exception, physicists who have contributed to school curriculum development have gained a

perspective on the teaching of physics at the college or university level which has occasioned significant new developments. Relationships, atrophied by decades of disuse, with colleagues in the colleges of education have been revitalized and courses for prospective teachers reformed. The problems of the student in the introductory courses for non-majors have been approached with a new sensitivity. New programs at the graduate level at some of our most prestigious research-oriented universities have been developed in an effort to institutionalize the benefits realized from the scholar-teachers as they become involved in the process of education.

Perhaps the greatest good that has come from this work has been the development, within the physicists who have done school curriculum work, of a healthy respect for the schools and for school personnel. This is not to say that the schools are in a satisfactory state; in fact, to the contrary, they are scarcely better than their

most severe critics describe. What one realizes from detailed work is that there are talents and capabilities within the schools to be respected, cherished and nurtured. And one comes to realize how important it is that the full resources of the scholarly disciplines find their proper relation in support of the schools.

I can summarize my remarks on the contributions of physicists to school curriculum development and the contribution of school curriculum development to physicists in the following way. School curriculum development has proved to be a proper mechanism for the detailed involvement of physicists in the schools. But the important effect has not been the resulting materials, important as they may be, but the development of the human resources both in the schools and in the universities for carrying forward of the educational process. The development of school science curriculum materials has proved to be a successful mechanism for the direct interaction of a wide

range of individuals with responsibilities to the schools. The direct result has been marvelously creative, authoritative, and successful materials whose importance can be at best transitory; the long-range effect has been in the development of the individuals involved. There is a very large difference between building a monument and raising up a child.